CHAPTER 9

Controls and Instruments

A complex set of controls and instruments monitors the operation of an electric generator set. Equipment operators must understand what these controls and instruments monitor and how they work. Information about many controls and instruments is included in this chapter. Additional information about the controls and instruments for a specific generator set is in the manual issued with the set.

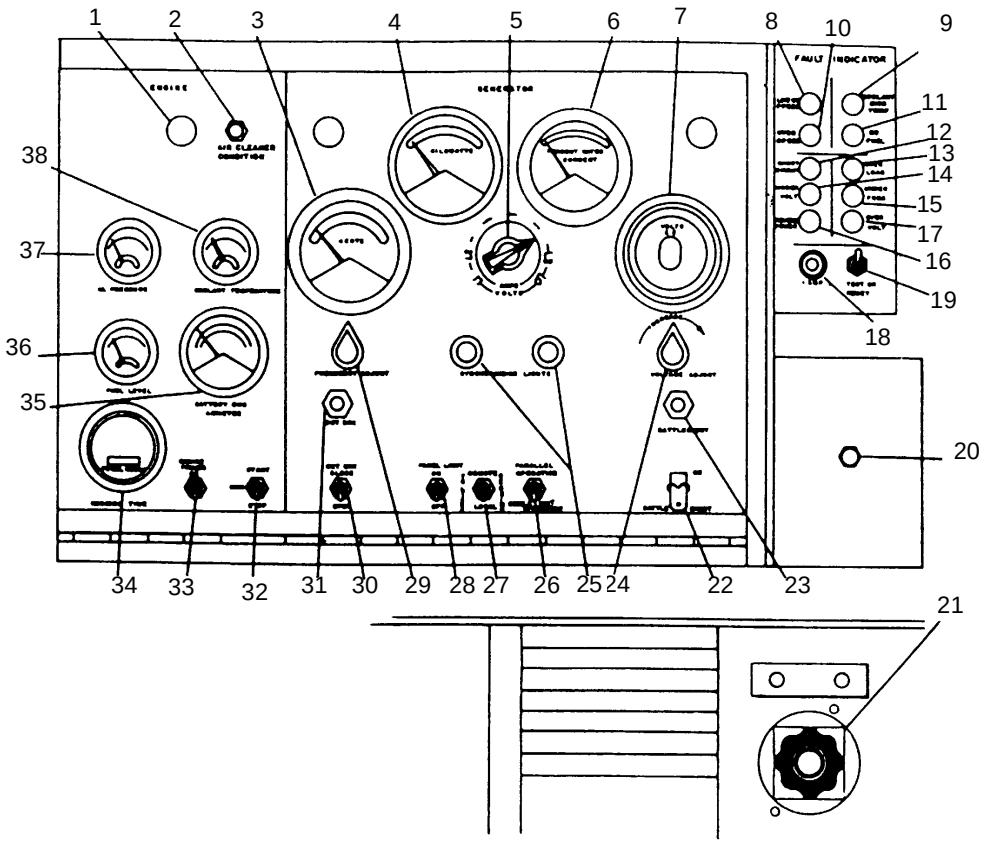
ENGINE CONTROLS

The controls and instruments used to operate a generator set are installed in a control panel similar to the one in *Figure 9-1, page 9-2*. **NOTE: In this chapter, the number in parentheses after the control name corresponds to the callout in *Figure 9-1*.**

The *DC circuit breaker* (20) protects DC circuits against shorts and emergency stops. When pressed in the start position, the *start-run-stop switch* (32) completes the battery circuit to start the motor. The switch is released and returns to the run position after the generator starts. The switch remains in the run position until it is placed in the stop position. The *manual speed control* (21) regulates the speed of the engine. The *heater controls (Figure 9-2, page 9-3*) operate the engine's heater. The control set includes a circuit breaker, a heater-on indicator light (press-to-test light), and an on-off switch. The press-to-test light is on when the heater is operating. The *three-way fuel valve* (*Figure 9-3, page 9-3*) directs the flow of fuel from the source of supply to the fuel pump. The valve has three positions—auxiliary fuel tank, set fuel tank, and off. The first two positions indicate the fuel source. For example, when the valve handle is in the *set fuel tank* position, fuel is drawn from the tank on the generator set.

SAFETY CONTROLS

Most generator sets have a safety-control system similar to the one in *Figure 9-4, page 9-4*. The system consists of relays, overspeed safety devices, and pressure-temperature controls. The generator shuts down when a safety device actuates. Safety devices stop the engine or trip the circuit breaker in cases of overspeeding, low fuel level, low oil pressure, or high coolant temperature. The *low oil-pressure indicator* (8) illuminates when the oil pressure drops enough to actuate the low oil-pressure safety device. The *coolant high-temperature indicator* (9) illuminates when the coolant temperature rises enough to actuate the coolant high-temperature safety device. The o*verspeed indicator* (10) illuminates when the engine speed exceeds the rated rpm and the overspeed safety device (*Figure 9-5, page 9-5*) actuates. The *no-fuel indicator* (11) illuminates when the fuel in the tank is low enough to actuate the no-fuel protective device.



1. Panel-illumination light
2. Air-cleaner condition indicator
3. Frequency meter
4. Kilowatt meter
5. Volts-amps selector switch
6. AC ammeter
7. AC voltmeter
8. Low oil-pressure indicator
9. Coolant high-temperature indicator
10. Overspeed indicator
11. No-fuel indicator
12. Short-circuit indicator
13. Overload indicator
14. Under-voltage indicator
15. Under-frequency indicator
16. Reverse-power indicator
17. Over-voltage indicator
18. Fault-location indicator fuse
19. Test or reset switch
20. DC circuit breaker
21. Manual speed control
22. Battle-short switch
23. Battle-short indicator
24. Voltage-adjust rheostat
25. Synchronizing lights
26. Parallel-lights switch
27. Voltage-sensing switch
28. Panel-light switch
29. Frequency-adjust rheostat
30. Circuit-breaker switch
31. Circuit-breaker indicator
32. Start-run-stop switch
33. Engine-primer switch
34. Hour meter
35. Battery-charge ammeter
36. Fuel-level gauge
37. Oil-pressure gauge
38. Coolant-temperature gauge

Figure 9-1. Typical generator control panel

The *battle-short switch* (22) permits emergency operation of the generator. This four-pole, on-off switch prevents the generator from starting after a safety device actuates by locking out the starter circuit. It bypasses all protective device circuits except the overspeed and short circuits. During normal operations, the battle-short switch is in the off position.

ENGINE INSTRUMENTS

Several instruments monitor the engine's operation. The *oil-pressure gauge* (37) indicates the amount of oil pressure maintained in the engine. The *coolant-temperature gauge* (38) indicates the temperature of the engine coolant. The *fuel-level gauge* (36) indicates the amount of fuel in the main tank. The *battery-charge ammeter* (35) indicates the condition of the batteries and the charging system. The *hour (time-totalizing) meter* (34) indicates the amount of time the generator set has operated.

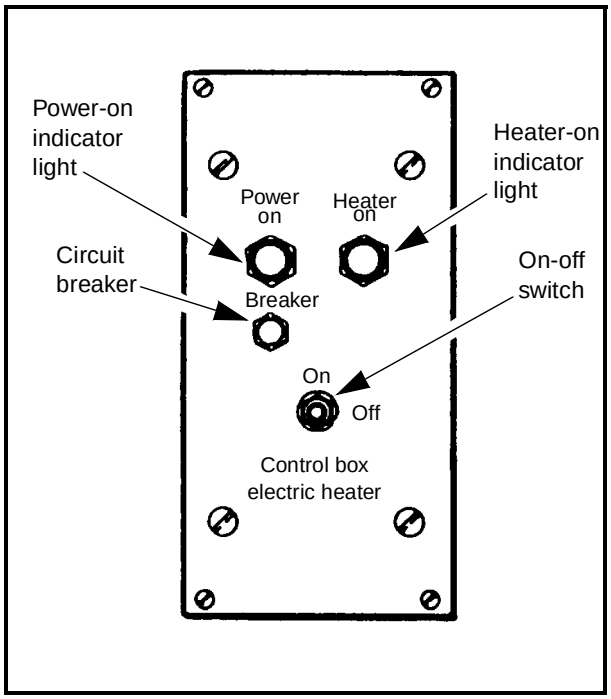


Figure 9-2. Typical heater controls

AC GENERATOR CONTROLS

Several controls monitor the operation of an AC generator. The *volts-amps selector switch* (5) provides current and voltage readings for each generator phase. A meter is connected to each phase of the main generator. Most switches have six positions that are plainly marked on the face of the selector plate. The *phase-selector switch* (*Figure 9-6, page 9-5*) changes the output of a generator to match the voltage and phase requirements of the load. This rotary-type switch is used on generators that produce as much as 10 kilowatts of electricity; changeover boards are used for generators that produce 15 or more kilowatts. The *parallel-lights switch* (26) closes the synchronizing-lights circuit in preparation for paralleling two or more power units. It is usually a two-position, rotary or toggle switch. The *voltage-adjust rheostat* (24) adjusts the value of the output voltage. The rheostat is a small, variable resistor. The *circuit-breaker*

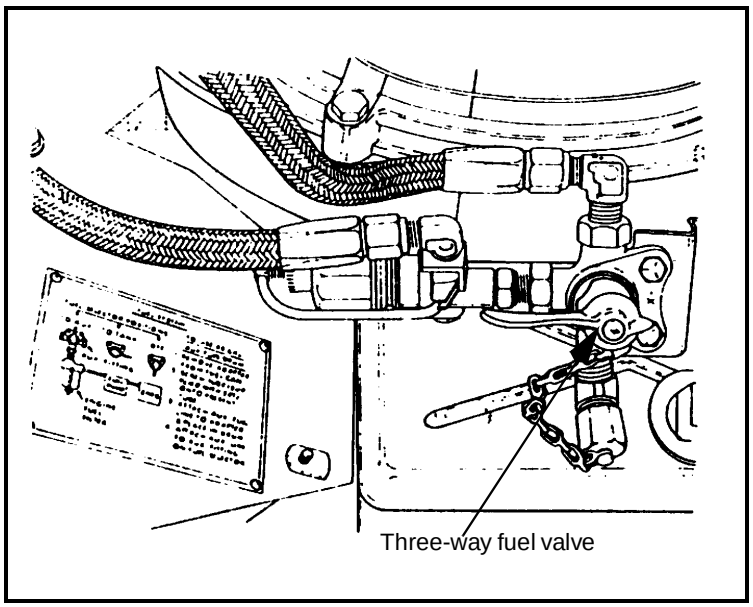
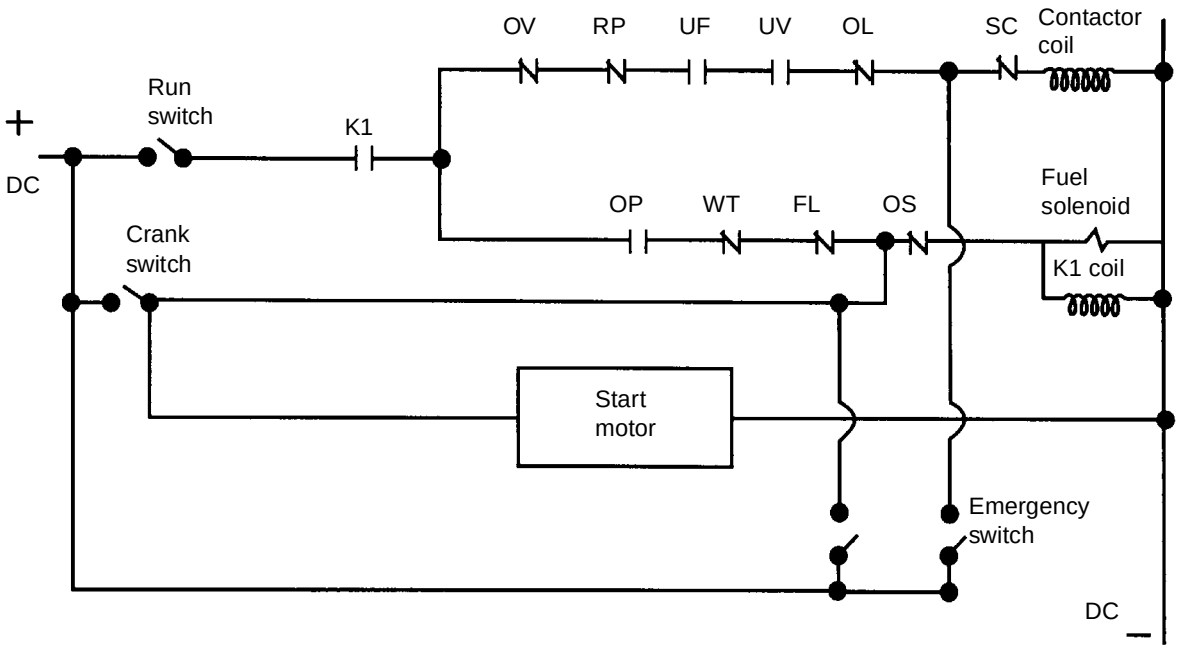


Figure 9-3. Three-way fuel valve

switch (30) disconnects and connects the load lines from the generator set. This switch acts as a main switch and an overload protective device. The circuit breaker automatically disconnects the load from the generator in case of overload, short circuit, or ground on the load lines or within the equipment being powered.

AC GENERATOR METERS

Various meters monitor the output from an AC generator. The *AC ammeter* (6) indicates the current output of the generator. The output is usually a percentage of the rated load. The *AC voltmeter* (7) indicates the voltage of the output terminals and, therefore, the voltage output of the generator. The *frequency (hertz) meter* (3) indicates the line frequency of the generator output in cycles per second. This dial-type meter is used for 50-, 60-, and 400-cycle generators. The *kilowatt meter* (4) indicates output from the generator. The output reading, in percent of kilowatts, must not exceed the rated capacity of the power plant. The operator must reduce the load if the output reading exceeds the rated capacity of the power plant.



F9-4

1. K1 Run relay
2. OV Over voltage
3. RP Reverse power
4. UF Under frequency
5. OL Overload
6. SC Short circuit
7. OP Oil pressure
8. WT Water temperature
9. FL Fuel level
10. OS Overspeed
11. UV Under voltage
12. DC Direct current

Figure 9-4. Practical wiring diagram of a safety control system

CONVENIENCE OUTLET

The generator contains a 120-volt AC convenience outlet that provides outlets for lights around the generator set. Fuses or a circuit breaker protect the outlet from overloads.

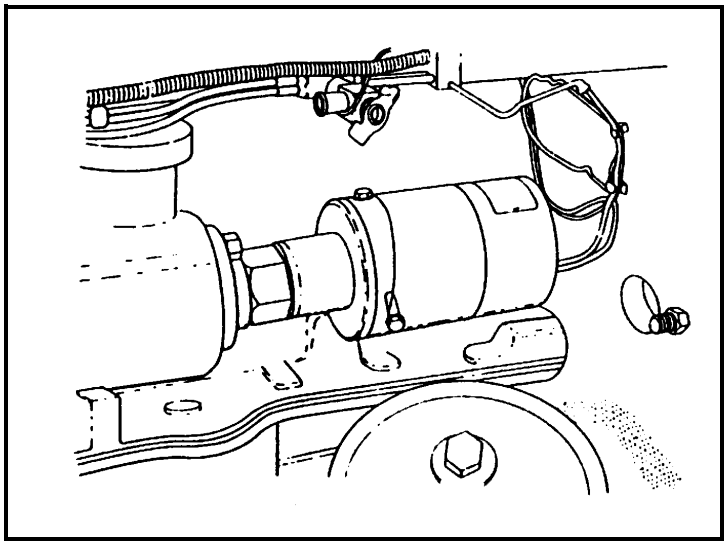


Figure 9-5. Overspeed safety device

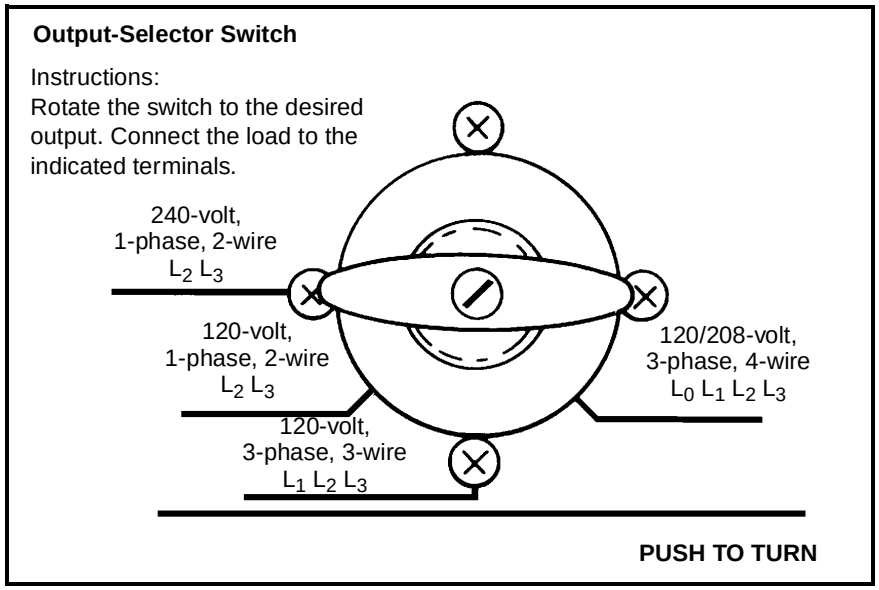


Figure 9-6. Phase-selector switch